Objective:

To carry out the electrolysis with two metals in copper (II) sulfate solution and to link their findings with the industrial electrolytic refining of copper.

Introduction:

In chemistry, you might have learnt that some reactions proceed easily (spontaneously) either naturally or on application of heat. Other reactions can only occur *(need to be forced to proceed)* by supplying energy with an externally applied electric current, for example, a battery. This process is called electrolysis.

Electrolysis is important in that it is used in the extraction of reactive metals, such as potassium, sodium, calcium, magnesium and aluminum; electroplating metals to improve their appearance and reduce corrosion/prevent rusting and in refining metals such as copper. For example, copper is mined in Kilembe and is transported to Jinja for purifying electrolytically.
Electroplating can be done at home once you have the necessary substances to use and intend to start a small business, for example, coating iron or aluminum bangles with copper.

Materials and Apparatus:

DC power, 1L beaker, 2 insulated electrical wires with crocodile clips at each end.
Electrodes: Metal strips of Tin, Aluminum, and Copper.
Electrolyte solution: CuSO4 solution, of any Molarity.

Procedure:

Part A: Electrolysis of aqueous copper (II) sulfate

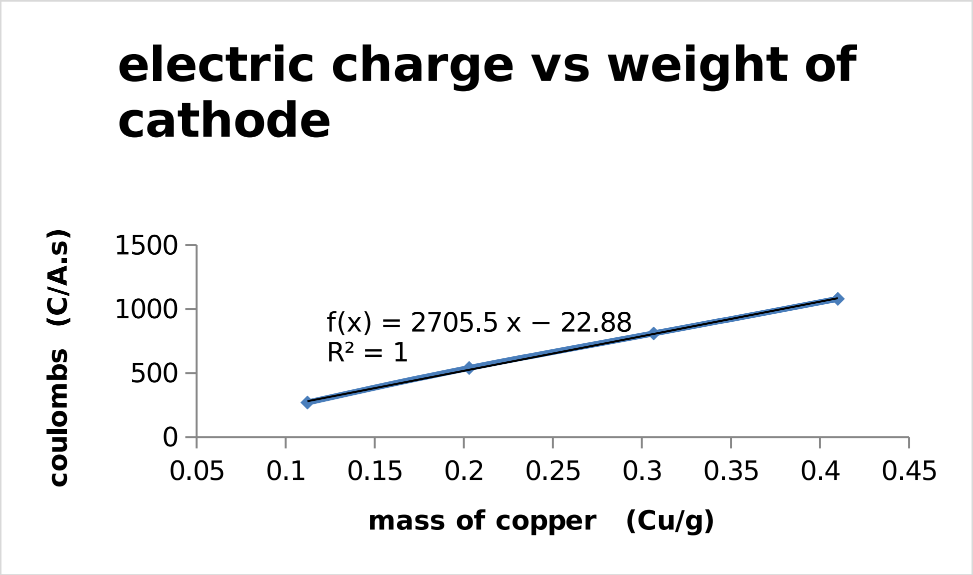
1. Both + and – electrodes were obtained. Then they were cleaned with emery paper, then they were rinsed with distilled water and were dried after that.
2. Their masses were recorded down.
3. Electrolyte solution was filled about 2/3 in a 1L beaker.

4. The Anode and the Cathode were immersed by clamping them to the rim of the beaker used the crocodile clips.
5. The electrodes were connected to the instrument.
6. After the current had been switched on, it was set to 0.3A to pass through the solution.
7. After 15 minutes, the electrodes were removed from the electrolyte, and they were washed with distilled water, then they were dried.
8. The dry electrodes were re-weighed.
9. It was repeated many times.
10. The electric charge was calculated using Q=It.

Results and Discussion:

The initial mass of the AL strip = 4.3623 g
The current = 0.3A is constant.

Time / min	Time / s	Mass of the strip after electrolysis / g	Mass of the pure Cu / g	Q (A.s)
15	900	4.4745	0.1122	270
30	1800	4.5653	0.2030	540
45	2700	4.6689	0.3066	810
60	3600	4.7723	0.4100	1080



The experiment was carried out to determine as well as to observe the mass amount of Cu that transfer from the Anode (Cu copper strip) to the surface of (AL) which represented as Cathode. So that transferred Cu which implicated on the surface of AL will be mentioned as the pure Cu because the electrodes were gone through some reactions in terms of electron transfer which can be expressed as follow:

- **Anode:** $Cu^{2+} + 2\grave{e} \rightarrow Cu$
- **Cathode:** $Cu \rightarrow Cu^{2+} + 2\grave{e}$.

So the transformations of the electron was still being done during the constant measurements of the current (0.3A) and the voltage (3V) which make no big difference between the Cu transfer at the all steps.

As it can be seen from the graph above that the relation between electric charge and the weight of the copper is proportional means that in the increment of the pure Cu on the cathode surface, the electric charge is increasing, due to the accurate correlation coefficient of the line that is close to one, according the reaction above which states that the Cu ion on the anode electrode is transferred until reaches the cathode which is converted it to pure Cu. In fact, the electrolysis is used in much application in the industries for separation (i.e; electrolysis in breaking down of a compound in solution into its elements by means of an electric current). Nowadays, some factories actually start to use the membrane between the electrodes. The membrane is used to separate the anode from the cathode in the same solution, but the good character that it allows only the anode to transfer to the cathode without reversely transfer so which means it give a higher purity that the diaphragm cell and also lower energy consumption.

- **Given the following assigned problem:**

In an electrolysis of copper electrode in aqueous copper (II) sulfate solution, 6.35g of copper deposited at the cathode.
a. Calculate the number of coulombs needed. (Given 1Faraday=96500 coulombs)
b. Calculate the time that a current of 4 amps must pass to deposit this mass of copper.

Solution:

Since the general Faraday's rule is:

$$W = \frac{I.t.A_{wt}}{n.F}$$

Where:
W: weight of the plated metal in g.
I: current in Amp.
A: atomic weight of the metal in g/mol.
n: valence of the dissolved metal in solution in equivalents/mole.
F: Faraday's constant in C/equiv. (Hence: 1F=96500 C/equiv.).

a. Given data:
   W= 6.35 g.
   1F = 96500 C/equiv.
   A_{wt} = 64 g x ($6.023x10^{-23}$/mol) = $3.85x10^{-21}$ g/mol.
   n= 2 equiv. x ($6.023x10^{-23}$/mol) = $1.2046x10^{-22}$ equiv/mole.
   Q = I.t. coulombs.

$$W = \frac{I.t.A_{wt}}{n.F} = \frac{Q.A_{wt}}{n.F}$$

So

$$Q = \frac{n.F.W}{A_{wt}} = \frac{(1.2046\,x10^{-22})\,x(96500)\,x(6.35)}{3.85\,x10^{-21}} = \frac{7.37\,x10^{-17}}{3.85\,x10^{-21}} = 19143\,C.$$

Q = 19143 C.

b. By using the following rule:

Q = I.t

Given data:
I = 4 amps.
Q = 19143 C.
So
T = Q/I = 19143/4 = 4786 s

T= 4786 s
T= 79.8 min.

Conclusion:

I concluded from the experiment how I can carry out the electrolysis of the copper (II) sulfate solution as well as I got absorbed investigating the identity of the products formed at the electrodes which was identified according to the reaction that was expressed.

Limitation of the experiment:

Actually there can't be any limitation which can affect our results, but the one which can be written is that we supposed to do the experiment with the whole significance while was not been done is, the students didn't link their findings with the industrial electrolytic refining of copper and that was the reason why I didn’t write down the part b of the experiment which talks about The purification of copper electrolytically.

Reference:

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